云 南 植 物 研 究 2001, Suppl. XIII: 59~68
Acta Botanica Yunnanica

Development and Conservation of Agrodiversity by Small Farmers: A Case Study from Yunnan, Southwest China

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Abstract: Yunnan is the most both biodiverse region in China. An existing project of People, Land Management and Environmental Change of United Nations University aims to document the status of agrodiversity as a basis for meeting local needs, using Xishuangbanna and Baoshan as case studies. Studies reveal that a rich agrodiversity at levels of crop species and varieties, plant species in agricultural fields and diversified ecosystems have been developed and conserved through agricultural systems by small farmers. Social - economic influences on agrobiodiversity are quite complex, but land tenure, household income and farmer association have played an important role in management of agrodiversity.

Key words: Development and Conservation of Agrodiversity; yunnan
CLC number: Q948 **Document Code**: A **Article ID**: 0253 - 2700(2001)sunnle XIII - 0059 - 10

1 Background

Agriculture can be viewed as supportive of biodiversity conservation, since the same places that produce our food and other living essentials also hold the great richness of life. This biodiversity plays an important role in agricultural processes. Agriculture forms a powerful basis for personal, experiential development of a profound meaning and connection to a setting or landscape (Lockwood, 1999). Furthermore, the wide diversification of crops and agricultural ecosystems created and experimented with small farmers may be the source of sustainable agriculture in the future (Brookfield & Padoch, 1994).

Yunnan Province of China, like much of the rest of the region, is dominated by rugged mountainous topography, climatic variability and biological diversity, and is populated by diverse cultural minority groups. Historically, these cultural minorities have practiced shifting cultivation, which depends on clearing native forests to plant agricultural crops. The main crop is upland rice, but hundreds of other secondary crops such as fruits, medicines and vegetables are interplanted for their livelihood. Development projects, commercial exploitation and increasing demands have led to the displacement of the rice swiddens by rubber, tea, coffee, fruit, sugarcane and other commercial crops. This leads to not only a problems in loss of biodiversity but also changes in agrobiodiversity at levels of crop species and varieties, and indeed at the ecosystem level as hundreds of species planted in cycling shifiting cultivation fields are transformed into permanent cultivation of monocultures. Although agriculture has dramatically changed from traditional approaches, many traditional crops and land uses continue to be widely practiced by small farmers throughout the region. There is urgent need to study these transformation processes and understand their implications to future sustainable agriculture.

The China cluster (Yunnan) of the People, Land Management and Environmental Change project of United Nations University (PLEC/UNU) was formed in 1994. The initial phase of study established four agrodiversity demonstration sites in Yunnan. A second phase, from 1998 to 2001, has been investigating farmer practices that both develop and conserve agrodiversity and meet local needs. Scientists and experts from multiple institutions are working closely with farmers to identify and further devewlop such valuable practices.

This case study focuses on agrodiversity conservation and development at the field level and the strategies of smallholder farmers in Yunnan, southwest China to manage their biological resources by examining the re-

sults of fieldwork at the PLEC/China demonstration sites. Relationships between social – economic, management and biophysical factors and how they impinge on agribiodiversity are assessed and discussed.

2 Study area and its biodiversity

Yunnan is a frontier province in southwest of China, situated between 21°8′32″ to 29°15′8″ north latitude and 97°31′39″ to 106°11′47″ east longitude. It encompasses an area of 394 000 square kilometers, covering 4.1% of China's territory. It borders on Guizhou province and Guangxi Zhuang Autonomous Region in the east, Sichuan province to the north, Tibetan Autonomous Region of China in the northwest, Myanmar in the west and both Laos and Vietnam in the south.

Yunnan encompasses a wide rangs of environments, including tropical and subtropical rainforest, temperate uplands and cool highlands of Hengduan and Gaoligong Mountains of the Himalayan range. Approximately 94% of the total area is mountainous and hilly terrain, with river valleys comprising the remaining 6% and most suitable for agriculture. By the end of 1999, Yunnan's population had reached 41.92 million, of which more than 13.95 million are ethic minorities. Of the 55 minority groups in China, 51 can be found in Yunnan. Twenty – five ethnic minority groups live in compact communities, with a population mor than 5000 respectively. Of these minority groups, 15 are indigenous to Yunnan, ranking it as the first in China in terms of number of indigenous ethnic minority groups. These include: Bai, Hani, Dai, Lisu, Wa, Lahu, Naxi, Jingpo, Bulang, Pumi, Nu, Deang, Dulong and Jinuo.

Yunnan boasts the largest variety of plants in China and is known as the "Kingdom of Flora". Of the approximately 30 000 species of higher plants found in China, Yunnan claims 274 families, 2 076 genera and 17 000 species. In addition, there are 2 100 species of ornamental plants, of which over 1 500 are floriferous. Quite a few are rare and endemic to Yunnan. Because of its unique climate and geographical environment, Yunnan is also home to a wide variety of wildlife. This remarkable animal kingdom makes its home in a wide range of environments, ranging from frigid, temperate to tropical climates and includes 1 737 species of vertebrates and more than 10 000 species of insects. Among the vertebrates, there are 300 species of mammals, 793 birds, 143 reptiles, 102 amphibians and 366 freshwater fish. In the fish category alone, 5 families, 40 genera and 249 species are endemic to Yunnan.

Many effects have been made to conserve this huge diversity. Forty – three nature reserves have been established in Yunnan at national and provincial levels since 1958 in Yuanan. In recent years, more nature reserves have been established at the prefecture and country levels. The total conservation area is now up to 1.95 million ha. Among them, both the Xishuangbanna Nature Reserve and Guoligoing Nature Reserve are members of MAB – UNESCO. Tens of plants have been listed in the state red book for conservation. A further 46 species of animals and birds are listed as state – protected and another 154 species are under second – grade protection.

3 Development and conservation of agrobiodiversity through agricultural systems

3.1 Farmer creativity in harnessing crop diversity

Production of agricultural crops dominates Yunnan' s economy, in part because of its frontier location, difficult access to the rest of China, mountainous topography, poor rural development, its rich natural biodiversity, and the diversity of cultural minority groups that farm its slopes. It contains a great repository of agricultural knowledge, developed through long creativity and experimentation with crops by smallholder farmers.

Shifting cultivation has been widely practiced in the area to produce a rich diversity of crops. Agricultural crops such as upland rice, wet rice, tea and all kinds of fruits are grown in a great diversity of varieties. Many of these crops, such as rice (*Oryza sativa*), tea and lithi, originated from this area. Considerable effects to survey this diversity have been made by the Chinese Academy of Sciences, the Yunnan Academy of Agriculture Sciences, and the Agriculture Department of the Yunnan government. For example, 5 128 samples of rice have been collected and stored (Guo and Long, 1998).

Since adoption of the reform policy and its opening up, Yunnan has undergone rapid economic and social development. Agriculture continues to grow, consolidating and reinforcing it position as the foundation of the economy. Sustainable development of the rural economy has facilitated continuous bumper harvests, reaching 12.46 tons in 1996. Higher value crops have been planted in increasingly larger areas. Tobacco, rubber, tea, sugar cane, medicinal herbs and tropical fruits are produced on a large scale. Flowers, coffee and spice productions are on the rise. The impacts of this transformation on development and conservation of crop diversity have received little research attention until now.

3.2 Species diversity in agriculture

The number of species in farmers' cultivation activities and the number of domesticated and semi – domesticated species used by farmers reflect not only the richness of natural biodiversity, but also farmer knowledge in managing for their benefit. The species, patterns and processes utilized by farmers in Yunnan vary greatly between cultural minority groups and geographic areas.

As a point of illustration, a total of 315 species belonging to 219 genera and 85 families have been recorded as planted in homegardens of Dai group in Xishuangbannan prefecture. This richness of plants grown in Dai homegardens makes an important contribution to their livelihood (Guo and Long, 1998).

3.3 Diversified the agricultural ecosystems

Agriculture in Yunnan, particularly mountainous areas, is usually classified as shifting cultivation, but in fact, small farmers practice many kinds of agriculture, especially after their settlement in a fixed location. No group retains exactly the same agricultural practices as ancestors did. Many types of cultivated lands and artificial ecosystems have been developed. For example, 220 different agroforestry combinations have been catalogued in south Yunnan (Guo and Padoch, 1995).

3.4 Case studies of agrobiodiversity management by farmers

To better understand agrobiodiversity management by farmers, a field work has been undertaken to evaluate development and conservation of plant diversity within the agricultural practices of Baka and Daka villages, two of four PLEC/China demonstration villages, 60 km east of Jinghong, the capital of Xishuangbanna prefecture since 1998. Agrodiversity methodology, especially household based agriobiodiversity assessment has been used in this case study (Brookfield and Stocking, 1999; Guo *et al*, 2000).

Baka is a village in Jinuo Township, Xishuangbanna prefecture, with an elevation of 560 – 1 150 m. In 1971, six households moved to the present village site from the old village located about ten km away. This relocation was prompted by rapid population growth and poor transportation at the old village. Another six households moved to the village what is now a national nature reserve. A further 30 households moved from the old village in 1972. There are currently 56 families and 319 people in Baka, including 143 males and 125 females. The Jinuo community is the smallest of the total 55 cultural minority groups in China. They have lived in the Jinuo Mountains for generations, primarily as shifting cultivators. Chinese cardamom (Amomum villosum) is a medicine cash crop grown by small – scale producers in the humid lowland tropics. It is often grown

under the canopy of natural forests. It is very popular in Baka and has been a major source of income since the 1980s (Guan *et al*, 1995).

Table 1 Overview of land use at Baka study site

Land – use stage	Field type	Area (mu*)	Percentage (%)
Reserved forests	Water source forest	300	11.5
	Holy hill	3	0.1
Cultivated lands	Fallow	1 400	53.8
	Paddy field	80	3.1
Crop gardens	Hevea brasiliensis plantations	633	24.3
	Amomum villosum plantations	294	11.3
	Passiflora caerulea plantations	200	7.7
	Camellia sinensis plantations	25	1.0
	Cassia siamea plantations	55	2.1
Rusty fields	Rusty field	100	3.8
Homegardens	Homegarden	10	0.4
Number of field types		11	
Total area		2 600	100

* 15 mu = 1ha

Table 2 Overview of land use at Daka study site

Land – use stage	Field type	Area (mu*)	Percentage (%)
Reserved forests	Water source forest	400	3.7
	Holy hill	100	0.9
	Scenic forest	100	0.9
	Community forest	4 000	36.7
Cultivated lands	Fallow	950	8.7
	Paddy field	295	2.7
Crop gardens	Hevea brasiliensis plantations	2 800	25.7
	Amomum villosum plantations	250	2.3
	Passiflora caerulea plantations	750	6.9
	Camellia sinensis plantations	5	0.1
	Cassia siamea plantations	40	0.4
	Citrus grandis plantations	40	0.4
Water	Stew	5	0.1
Rusty field	Rusty field	1 100	10.1
Homegarden	Home – garden	75	0.7
Number of field types		15	
Total area		10 910	100

* 15 mu = 1 ha

Daka is a Hani village in Menglun Township, Mengla County, Xishuangbanna prefecture. Hani is the second largest minority group in Yunnan. The village is located on the mid – slopes of a mountain at an elevation of 540 – 1100 m. The village was originally located nearby Huiban village, about seven km away. In 1966, some people moved out and established Daka village at its present site. Fifty – six families and 319 people now live in Daka, include 153 males and 166 females.

In the study area, the climate is a monsoon climate with an average annual rainfall of 1 500 mm, 82% of which falls between May and October. The annual mean relative humidity is 83%. The mean annual temperature is 21.5℃, ≥10℃ accumulated temperatures is 7 811℃.

Tables 1 and 2 show the land uses in both study villages. In Baka, there is a total of 2 600 mu land (Note: 1 ha = 15 mu). Landscapes are comprised of a patchwork of community forests, crop plantations, and paddy fields besides traditional shifting cultivation. Despite economic development and population increases, Jinuo still practice the old'slash – and – burn' or shifting cultivation method of farming this mountainous

area. But rates, magnitudes and technologies have changed greatly. Shifting cultivation land accounts for 53.8% of the entire village area, but this figure is decreasing as cash plantations expand in response to farmers' need for permanent income. Traditionally, the fallow period in this area was 13 years, but has now shortened to 3 – 5 years due to land – use pressures. Furthermore, more "effective" agricultural techniques have been adopted, such as beginning to plough the land during the second or third cropping years. Thus, greater production benefits can be achieved in a shorter time frame.

There is both more shifting cultivation and wet rice terraces per person in Daka, as compared to Baka. Secondly, agricultural land is more gently sloped in Daka. Daka has 220 mu of wet rice terraces. A single crop of rice is planted yearly, with watermelon planted in most of some fields as a winter crop. The major income comes from the rubber plantations in Daka. Forty – seven households have begun to earn income from rubber sales, and the average income per household is about 5 000 Yuan/year (Note: 1US $ = 8.23 Yuan). Amonum villosum planted under community forests provides the second largest source of cash income.

Upland rice is the main crop in shifting cultivation fields, with annual yields of 400 – 700 kg/mu. Other crops, such as cotton, soybean, and groundnut are often intercropped with upland rice. The number of crops and varieties planted in swidden fields has decreased greatly in this region. In this study, field inventories and householders interviews were conducted on upland rice diversity in Baka. We recorded local names of upland rice varieties, and later collected data on their sowing time, type, shape, and other characteristics.

Twenty varieties of upland rice are grown in Baka (Fu & Chen, 1999). These varieties can be classified according to i) sowing time (early, middle and later); ii) variety (non – glutinous and glutinous); iii) color (red, white, and mixed); and iv) most suitable temperature (cold resistant, heat – resistant and broadly tolerant). There are two reasons why this village is planting such a diversity of rice varieties. One is that the altitude of the village shifting cultivation fields ranges from 550 to 1050 m. Secondly, new varieties are easily introduced into this village since it is now near the road.

In Baka, some varieties are planted more widely than others due to three main factors are: variation in natural conditions, mainly temperature, at different altitudes, differences in the economic situation among households, and differences in soil fertility.

The biggest change in the landscape is the expansion of cash crop plantations, including rubber, passionfruit, pomelon, litchi and tea. Agroforestry systems are widely practiced as an alternative to shifting cultivation. They can be classified into indigenous practices and more recent innovations. They have different productive aims and components. Table 3 shows the main agroforestry practices in Baka and their characteristics.

Table 3 Categorization and description of agroforestry systems in Baka

Categories	Models	When appeared	Key components	Characteristics	Product purposes
Indigenous practices	Burn & slash	Long history	Forest, cereal staples, vegetables	Rational system of crops and forest	Mainly for subsistence use and some exchange
	Forest farming	Long history	Forest, *Camelia sinensis var*, *assamica*	Economic perennials planted under forests	
	Taungya	Since 1970	*Cassia siamea*, *Gossypiumhirsutum*, agricultural crops, etc.	Learnt from Dai people	
	Home garden	Since settlement	Vegetables, fruit trees, *Jatropha curcas*, etc.	Improve microclimate	
Present practices	Taungya	Since 1970s	Rubber trees, agricultural crop, vegetables, tea tree, etc.	Simultaneous systems.	For both home use and sale
	Forest farming	Since 1970s	Forest, Chinese cardamom	Alternative to growing tea under forest	
	Passion fruit crops	Since 1993	Passiflora cearulea, economic trees, agricultural crops	Provides combination of short – and long – tern benifits	
	multi – storied orchard	Since 1980s	Fruit orchards	Long – term benefit (simultaneous systems)	

With changing land use in this village and its impact on biological resources, farmers have changed their management strategies. For example, fuelwood used to be collected when fallowed fields were opened for cultivation. A survey of 60 percent of Baka households showed that 34.5 percent of fuelwood consumed now comes from fuelwood plantations, 14.5 percent from community forests, 44.2 percent from household forests, and 6.7 percent from the nature reserve. The kinds and quality of firewood in Baka have also changed over time (Zeng *et al*, 2000).

Daka village site located on steeper slopes. Homegardens have been more developed than in Baka, and assist to preserve agricultural species. Nine homegardens were sampled in Daka. The results showed great variation in plant species richness between sampled homegardens. Furthermore, hierarchical agglomerative analysis of the results indicated that plant community similarity between different households was low. The species – household curve of homegardens showed that the minimum sampling percentage was 15% based on the fit and assessment of model curve $S = a + b\ln B$ (Cui *et al*, 2000). The survey found 165 plant species, 124 genera in the sampled plots, of which were being utilized by local households.

There are more species maintained under the less intensive land use prevalent in Daka. Eleven 10 × 10 m quadrants of different land management systems were established in Daka, and nine in Baka. Four 1 × 1m sub – quadrants were established in the corners of each quadrant to investigate the individual number of undergrowth species. The survey of plants utilized under different land management systems was undertaken at the same time. We found 73 families, 139 genera and 179 species distributed in the total of 0.1 ha of quadrants sampled under different land management systems in Daka. And 70 families, 146 genera and 166 species were distributed in the total of 0.08 ha of quadrants sampled under different land management systems in Baka. Cosmopolitan families, such as Compositae and Papiloinaceae, account for about 20% of total species recorded in Daka and Baka (Fu *et al*, 2000a). The percentage of tropical and subtropical families in different land management systems was comparatively lower than for a native tropical rainforest.

Compared with the complex canopy structure of tropical rainforest, canopy structure of different land management patterns was simple. Furthermore, some layers disappeared entirely from some land management patterns. Lianas, for example, disappeared in 45% of all quadrants in Daka, and 44% in Baka. Land management had reduced biodiversity through simplification of the canopy. Comparison of canopy layers and life forms indicated that there were fewer plant species distributed under the tree layer, although there were higher volumes of biomass in the managed land. Use of trees for construction wood and fuelwood has led to the disappearance of those best suited for those purposes (Fu *et al*, 1999).

There were great variations in the diversity indices recorded in different land management systems. In Daka, the species richness index varied from 0.02 in paddy fields to 0.26 in community forests, while the agro – species richness index varied from 0.03 in reservoir dike to 0.75 in community forests. This indicates that conversion of natural forest into agricultural fields has greatly reduced biodiversity. In Baka, the species richness index varied from 0.04 in upland fields to 0.28 in plantations under natural forest. The agro – species richness index varied from 0.04 in orchards to 0.52 in home gardens. This shows that simple – artificial plantation and particularly slash – and – burn agriculture had greatly reduced biodiversity. On the other hand, the natural forest had conserved much more biodiversity. The Whittaker index varied from 0.58 tol in Daka, and 0.63 to 1 in Baka. This reflects that there were differences in species composition between land management patterns (Fu *et al*, 2000). Correspondingly, there were considerable variations in Jaccard's coefficient index between the different land management patterns. The index varied from 0 to 0.26 in Daka, and 0 to 0.23 in Baka. This variation within the diversity shows that different land management patterns contain different species composition, and hence lead to different succession processes.

4 Agrobiodiversity management by farmers

Agrobiodivity assessment provides not only basic data of agricultural diversity, but also further identifies environmental, institutional, social and economic factors that lead to development and change in agribiodiversity management. Preliminary findings have shown that agricultural activities and economic development do not necessarily eliminate biodiversity. On the contrary, some practices may enhance biodiversity while supplying food and other products to necessary for the livelihood of local farmers. However, the social – economic influences on agrobiodiversity are quite complex. This is illustrated below in a review of findings from PLEC demonstration villages in the Gaolingong area of Baoshan prefecture of west Yunnan, another PLEC/China region besides the Xishuangbannan prefecture.

4.1 Agrobiodiversity management changes under socio – economic development

In China, all land belongs to the government. Farmers formerly managed their resources and lands and worked together under a system of community land ownership. At that time, agro – production was allocated according to labour input. Agrobiodiversity management was less diverse, as each community planted essentially the same crops on their community farmlands. After launching of "Household Production Contract System" of land reform in 1982, land use rights were allocated to individual households in agricultural areas. Land tenure has changed dramatically since that time. Smallholder farmers now manage most land types, such as community forests, upland fields, wet rice terraces, cash crop plantations and homegardens. Smallholder farmers have many options to manage their land, which may include by using multiple crops and different cultivation systems.

Two examples from PLEC' s demonstration site at Baihualing village, Baoshan City of west Yunnan show how agrobiodiversity has changed based on resources and options available to farmers. Mr. Li Dayi (Yi) is a farmer with expertise in breeding and cultivation of timber trees. In 1982, he was allocated two ha of uplands from the community for corn cultivation. He has begun to plant a native timber tree (Phoebe puwenensis, propagating the seedlings by himself) and other timber trees since 1983. At present, his allocated land is covered by timber trees and other cash crops (Ammomum vilosum, etc.). Another example can be cited from another natural village in the same administrative village. Mr. Wu Chao – ming is expert in integrated land use. Since he has a big family, his household was allocated a big area of uplands in 1982. He began to plant the uplands (about one ha) with tree crops, such as chestnut (local cultivator), walnut, Chinese fir, Toona ciliate and so on since 1983. Our survey found 20 cultivated plants and more than 60 wild plants managed in his orchard. Some new cash crops with high market value have been introduced into his upland fields in recent years, e. g., Ammomum kravanh, which has been managed under agroforestry system. Walnut and/or chestnut have been intercropped with understory crops. He used his homegarden to propagate different kinds of seedlings, both for himself and other farmers. Table 4 shows species diversity within homegardens in this village. Species richness and number of useful species in homegarden vary significantly among households. Our survey found high species diversity in the homegardens, ranging from 34 to 85 in the sampled homegardens. The number of useful species ranged from 13 to 62, representing 38% to 73% of total species found in home gardens. Many useful wild species and semi – cultivated species are found in those homegardens.

4.2 Household income and its relation to agrobiodiversity

As shown in Table 5, the annual cash income of those households with diverse sources of income is generally higher than that of other households with fewer sources. This data is derived from PLEC's demonstration village, in Gaoligongshan area. This suggests that farmers who manage more varieties of crops (crop endowment, including cash crops) can obtain more cash income (financial endowment). But cash income of most households still largely comes from traditional cash crops, sugarcane and grain in this region. About half of an-

nual household cash income comes from these two crops. Sugarcane is the leading cash income source, accounting for 36.15% of total income. Sugarcane prices have decreased in recent years in response to international and domestic market demands. Local government controls the planting area and price of sugarcane. Cash income of those households depending only on sugarcane has seriously decreased in recent years. Most of these farmers are forced to seek off – farm work to supplement their income. Livestock, mainly breeding pigs, is also an important source of cash income, accounting for 15.1% of total household income. The most important findings here are that the households can obtain more sustainable cash incomes if they grow a diversity of crops and/or manage their land under agroforestry systems. According to our interviews, the cash income from agroforestry systems has been increasing yearly. For example, about 15% of annual cash income in Mr. Wu Chaoming's household comes from fruit trees with other crops grown as an understory.

4.3 Gaoligongshan Farmer' Association for Biodiversity Conservation

Table 4 Species inventories in sampled house gardens at Baihualing village

Farmer	Sample No.	Total Species	Timbers	Fruits	Tree Vegetables	Vegetables	Condiments	Medicines	Fodders	Ornamentals	Grasses	Border Plants
Peng Xueli	G1	85	2	16	3	22	4	5	4	6	8	15
Peng Dafan	G2	52	2	2	3	21	2	4	2	0	11	5
Yang Zhixue	G3 – A	40	0	7	1	8	1	1	1	0	16	5
	G3 – B	39	0	0	0	13	2	0	1	0	14	9
Wu Chaoming	G4A	75	0	10	3	23	3	5	2	8	16	5
	G4B	34	1	5	1	4	0	0	2	0	11	10
Xiong Weirong	G5	50	2	2	0	13	0	1	1	0	20	11
Duan Zhaoqi	G6	73	1	6	1	18	2	4	3	0	30	8
Zhang Mingshu	G7 – A	36	(Winter seasonal garden)			13	0	0	1	0	13	9
	G7 – B	44	0	6	0	11	1	1	0	2	13	10
Liu Zhanwei	G8A	51	1	8	1	18	3	2	2	0	11	5
	G8B	46	1	4	0	13	1	3	2	4	13	5
Hu Jixue	G9	76	1	4	1	16	3	5	3	4	23	16
Zhang Pincai	G10	56	2	5	0	21	2	2	2	1	16	5

The Gaoligongshan Farmers' Association for Biodiversity Conservation was established in 1995. It is the first NGO for environmental protection in China. It is an association of self – organization, self – management, self – development and self – service by its member of farmers. Its principle objective is to balance the relationship between biodiversity (mainly agrobiodiversity) conservation and sustainable rural development. It also opens channels between government departments and farmers, as well as donor projects and farmers. Membership of the Association has been as high as 108, of which ten are women. The Association has organized yearly training workshops on agrobiodiversity development, useful rural knowledge and biodiversity conservation. During training activities, farmers learn skills on grafting, pruning, dealing with plant diseases and insect pests, and other practical agricultural skills.

In recent years, the Association has begun to identify and organize expert farmers to demonstrate agrobiodiversiy. It is well known that farmers are principle actors in the management of agrobiodiversity. Farmers frequently have rich skills in planting, grafting, pruning, breeding and other agroforestry techniques. Once a farmer has been identified as expert farmer, he or she is invited to lecture at training events organized by the Association. Cross – visits by farmer trainees to expert farmer are also sometimes organized. One example is Mr. Chen, an expert in rice variety selection and cultivation. Two years ago, he began cultivating a high quality rice variety instead of the hybrid that he had formerly planted. Now, increasing number of farmers are cultivating this rice variety because of its superior quality and market value.

Table 5 Sources of income (Yuan*) in sampled households in the year of 1999 at Hanlong village

Farmer	Livestock	Chestnut	Walnut	Sugarcane	Coffee	Vegetables	Grains	Off farm income	Transportation	Total
Wu Chaoming	4 000	1 800	1 440	7 500	900		1 950	2 800	8 000	28 390
Liu Zhanwei	2 800		60	3 400	100	150	3 400	300		10 210
Duan Zhaoqi			30	2 040		20		220		2 310
Hu Jixue	800		600	2 000	640	60				4 100
Peng Dafan	1 900		300	3 600	1 000	120	1 200	600		8 720
Zhang Pincai			99	2 000						2 099
Xiong Weirong	700		1 000	4 000		200	1 850	1 200		8 950
Yang Zhixue		90	60	3 200		340	2 000	5 300	2 000	12 990
Zhang Mingshu	1 000			2 200		105				3 305
Peng Xueli	4 200			4 200	1 250		1 200	3 000		13 850
Yang Fujun	1 260			2 600			500	5 000		9 360
Yang Zhishun	600	40		600						1 240
Yang Guolian	600			400			725	3 000		4 725
Hu Yixing			600	3 000			315			3 915
Ynag Zhiguang	2 728		250	2 040			700	800		6 518
He Gengming	200	150	1 650		200			260		2 460
Xiong Weirshen	1 386			3 500		10	240			5 136
Liu Shaofeng	300	150		200		150		700		1 500
Liu Shaohua				3 000			215	600		3 815
Tang Zhenggui	1 800		10	2 910			326	2 700		7 764
Liu Yingze				600		50	5 120	3 260		9 030
Hou Jinfu				3 000		100	400			3 500
Dong Xinguang			300	1 000			180	100		1 580
Xiong Weirun	135		150				600	1 590		2 475
Tang Yongjian			150							150
Yang Fuqiang	800		200	3 000	250		1 180	180		5 610
Dong Debao				400		100	450	2 400		3 350
Total	25 209	2 230	6 899	60 390	4 340	1 405	22 551	34 010	10 000	167 034
%	15.10	1.33	4.13	36.15	2.6	0.84	13.5	20.36	5.99	100

* 1 US$ = 8.23 Yuan

5 Conclustion

The development and conservation of agrobiodiversity in agricultural systems is essential for a range of agronomic, economic and environmental reasons. Agrobiodiversity should be developed to support the livelihoods and wellbeing of local people, but wile still conserving traditional biodiversity resources. To some extent, a balance between agricultural production and biodiversity conservation must be struck. There is an urgent need to document changes in agrobiodiversity and trends induced by shifting cultivation and other alternative land use pracrices. The case studies demonstrate that a rich plant diversity has been persevered within farming systems, but with great variation between land management systems and the two study villages. With the high population pressures in Baka village, agricultural diversity may decline as land use intensifies. Daka, with its lower population density, has been more successful in preserving plant species within its farming systems. Dynamics of these changes and agricultural practices that would enable biodiversity conservation will be imperative if agriculture is to be sustainable in the future.

Agrobiodiversity is a new field of study. There remains insufficient data and objective information is alter public perception and policy until now. Future effects should pay more attention to training and education. More research is needed on existing strategies for on – farm conservation of agricultural diversity, especially indigenous systems that are able to both maintain soil quality and conserve biodiversity.

Acknowledgement: The research was funded by the project People, Land Management and Environment Change (PLEC) which is executed by the United Nations University, Tokyo, and implemented by the United Nations Environment Programme, Nairobi. Many thanks are given to Dr. Malcolm Cairns, International Center for Research on Agroforestry (ICRAF) Southeast Asia Regional Programme for his kindness comments and corrections on the manuscript. The paper is based on a commission of Environment Liaison Center International (ELCI).

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